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TOPOCLIMATOLOGICAL AND SNOWHYDROLOGICAL SURVEY OF SWITZERLAND

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HCMM-Investigation HCM-021 Progress Report No 2

TOPOCLIMATOLOGICAL AND SNOWHYDROLOGICAL SURVEY OF SWITZERLAND

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1. Techniques

1.1. Available Data

By the end of February 1980 we have received appr. 150 HCMM scenes (photographic products) from NASA, covering the period from May to December 1978. In addition the LANNION-facilities provided us with a great number of quicklooks.

From the above number of NASA-data 34 scenes include the western part of Switzerland under good atmospheric conditions which allow at least interpartial interpretation.

3 digital tapes have been sent by NASA, other will follow.

1.2. Data type, techniques

Basically we refer to Progress Report No 1 (August 1979). No essential changes in the procedures of collecting ground truth data and of evaluation techniques have been introduced.

- Photographic imageries
  The new characteristic curve (following NASA information of 11 July 1979) enables better differentiations in medium gray shades (visual interpretation). As a consequence e.g. urban thermal patterns (day time) are easily separable from surrounding rural areas.

- Digital data
  - Geometric adaption to Swiss topographic maps can be achieved with an accuracy of $\pm$ 1 pixel in each direction (up to 20 reference points are required in the correlation matrix).
  - Digital data serve partially as reference for thermal calibration of photographic products (see Chp. 2 and 3).

- Ground truth
  - First evaluations clearly show the need of a more extensive ground control program. The main reasons for this are as follows:
    1. Lake surface temperatures should be measured at several sites, because lake surfaces seem to be thermally quite inhomogenious (differences of up to 3°C could be measured within short distances) as a consequence of surface currents induced either by wind or by influxes.
    2. If possible radiometric measurements from aircraft should cover in future more different topographic units and terrain coverage types.
    3. The influence of surface humidity should be studied more in detail.

- Atmospheric corrections

2 HCMM scenes have been studied extensively in view of the atmospheric correction (using the NASA correction program as well as ground controls). The following remarks seem to be important:

1. Depending the meteorological situation the precipitable water content of the lower atmosphere may vary within short distances (200-300 km). Fig.1 shows the resulting corrections by using the atmospheric sondage values of neighbouring radio sondage stations.
2. The 2 evaluated scenes differ very much in view of the accuracy between the corrected satellite values and the respective ground controls: only in the first case we got excellent results.
   June 3, 1978, night-IR: mean differences $T_{HCMMcorr} - T_{groundtruth} = -1,0^{o}C.$

   May 16, 1979, night-IR: $T_{HCMMcorr} - T_{groundtruth} = -11,2^{o}C.$

   Up to now we cannot give any final answer for these differences. Further scenes will be evaluated.

2. Significant results

Basically the preliminary results of the first progress report could be refined.

2.1. Nocturnal temperature inversion zones

Low temperature zones depend on the topography and the terrain coverage type (beside the meteorological situation). The usual pattern of cold zones at the bottom of the valleys, warmer belts along the valley slopes and again cold mountain tops, this pattern is modified by the terrain coverage type. Rural and forested areas normally have different surface temperatures, but along a vertical profile the temperature decrease (or increase) is often in the same order of magnitude (fig. 2). Because there is also a close correlation between topography and terrain coverage (high percentage of forested areas at the valley slopes up to the timber line, much less along the valley floors) the surface temperature of the warm slope zone is increased compared to a valley profile with uniform coverage (fig. 3).

Daytime thermal patterns and temperature differences (day / night) have not yet been studied extensively.

2.2. Cloud observations

Following the investigations executed at the Swiss Meteorological Institute (Dr. Piaget) HCMM imagery does not reveal more essential information as the AVHRR one, except its better spatial resolution which facilitate greatly the quantitative and qualitative interpretation of these data. In so far it would be desirable that spatial resolution of the next generation of meteorological satellites will be ameliorated to about this order.

3. Problems

Some of the problems mentionned in the first Progress Report are not yet solved: rather long delivrance time for digital data; delays in providing data acquisition charts (partially compensated by the excellent quick-look service of the Lannion facilities).

At present one of our main problems is the calibration of the analog data (film products) for quantitative evaluations. Following the HCMM-Users' Guide (§ V-4.1) the gray scale should represent the input digital data range (0-255) resp. the total radiation range. Obviously it does not work like that and a direct quantitative evaluation of the images (gray tone ⟶ radiation temperature) does not seem to be possible. Although evaluation of CCT's is the more precise and sophisticated way, quantitative analog interpretation (with electronic image interpretation devices) may facilitate the interpretation of a large amount of images for certain problems (delineation of specific zones; determination of temperature gradients).

Errors in the atmospheric correction program provided by NASA affected the results in several cases. Comments are sent separately.

4. Recommendations

As mentionned before two improvements would facilitate evaluations:

1. Analog data (photographic products) should be calibrated with two scales: - gray scale versus digital values
   - gray scale versus radiation temperatures
2. Data acquisition charts should be provided more frequently.

5. Conclusions

Repeting the statements of Report No 1 we conclude:

- HCMM data are a very useful tool for the solution of fundamental problems of topoclimatology: thermal patterns at medium scale as a function of surface coverage, topography, meteorological situation and time of the day.
- Together with other meteorological satellite data (TIROS-N, NOAA-6 or METEOSAT) HCMM provides very valuable information about the spatial and temporal development of meteorological phenomena (inversion layers, heat islands, fog layers etc.). The same should be true for comparisons or calibrations of data between different satellites.
- A final statement for the use of HCMM-data for snow-hydrological surveys can still not yet been given, but following our radiometer-flights snow under melting condition (day and night) is separable from still frozen snow covers, which is important in connection with run-off predictions.

Fig.1: Atmospheric corrections derived from radiosondage profiles of neighbouring stations.
3.6.1978, night.

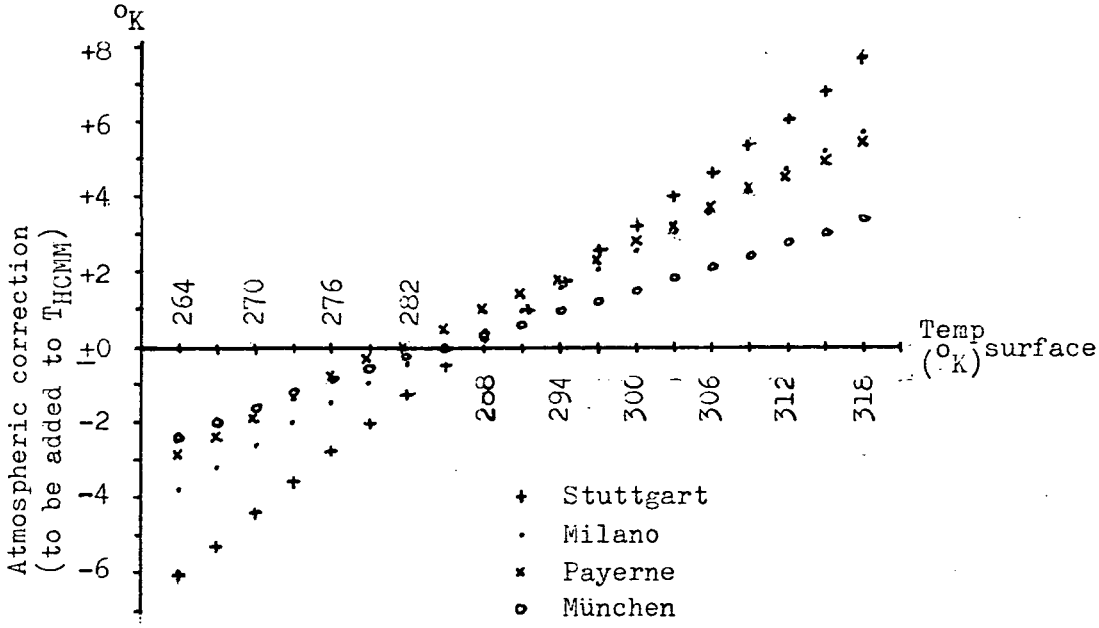


Fig.2: Surface temperature decrease with altitude.
HCMM-digital data, 16.5.1979, night-IR,
Jura mountains (Switzerland).

Temp.differences between the main surface coverage types, but comparable temp. gradients.

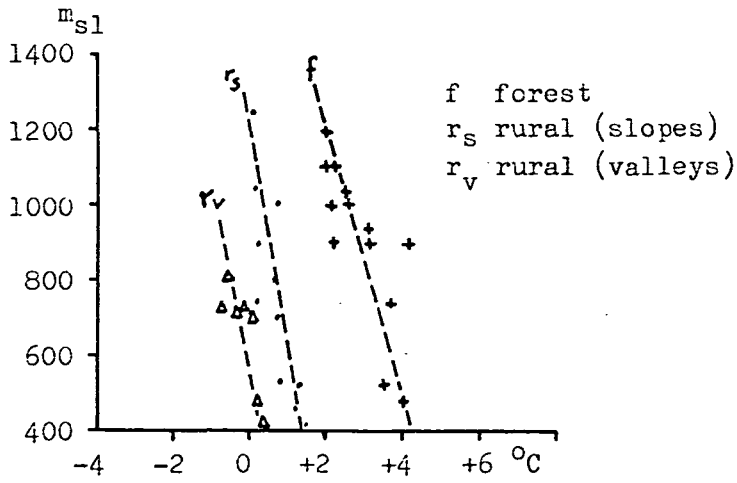
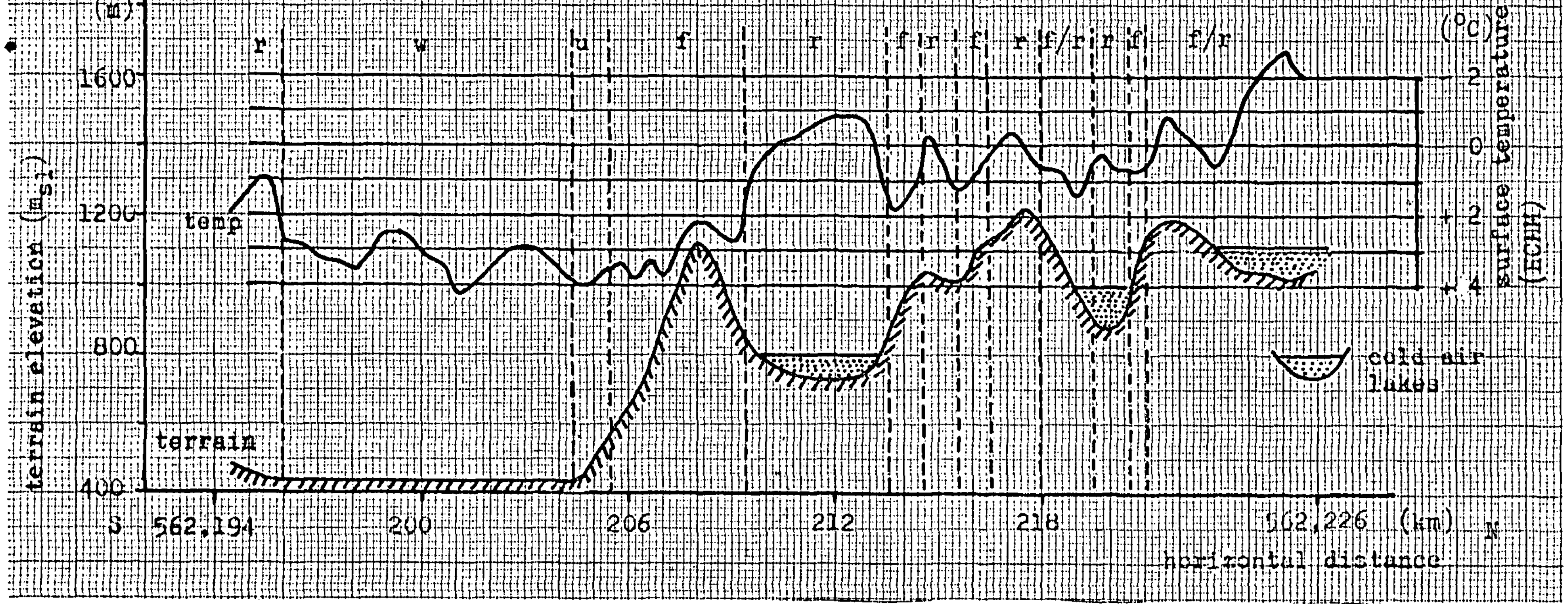


Fig. 3 : Satellite derived surface temperatures and their relation to topography, and terrain coverage type (r=rural, f=forest, w=water, u=urban) 16.5.1979, north-south cross section Jura mountains - Lake Neuchâtel



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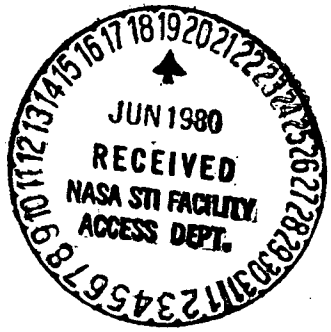
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